JPRS-UEE-93-006
10 August 1993

FOREIGN BROADCAST INFORMATION SERVICE

JPRS Report

Science & Technology

Central Eurasia: Electronics & Electrical Engineering

Science & Technology

Central Eurasia: Electronics & Electrical Engineering

JPRS-UEE-93-006 CONTENTS *10 August 1993*

Broadcasting, Consumer Electronics

Circuits, Systems

Computers

Industrial Applications

Quantum Electronics, Electro-Optics

Solid State Circuits

New Activities, Miscellaneous

A Computer Analyzes Signals

937K0240A Moscow RADIO in Russian No 6, Jun 93 pp 2-3

[Article by A. Kulaichev, V. Figurnov]

[Abstract] Fundamental principles of personal computer application for analysis of signals from examined objects are discussed. A standard computer is not designed for these operations, therefore, a controller with analog-digital conversion must be installed. Specialized programs are also needed for processing these signals. Two universal program systems for signal analysis, CONAN 1.5 and Flexlab, were offered at the latest software forum "SofTool-92". The Flexlab package contains a wide selection of programs for solution of metrological technical problems. Since this article deals with a more general range of problems, some samples of the CONAN system application are discussed. A signal analysis process using the CONAN system is described and pictures of the records are provided. It includes: 1) A display of planning an experiment for recording reactions to a sound stimulation; 2) A graph, where each horizontal line shows in color the spectrum of each stage of the experiment; 3) Visualization and editing of records; 4) A multidimensional controlled spectrum diagram; 5) Sequential charts of coherency changes between pairs of channels; 6) A chart of amplitudes of an object surface vibration. Application of personal computers and corresponding software is a most advanced, efficient and inexpensive way for analyzing the processes and signals. Figures 6.

What is Certification of the Radio-Communication Media

937K0240B Moscow RADIO in Russian No 6, Jun 93 p 4

[Article by V. Yelsukov]

[Abstract] The concept of certification of radio-communication media is discussed. This is a rigid procedure of certifying and issuing of a document by authorized authorities about conformity of any developed technical facilities to national, regional, and international norms and standards in force. Certification of the engineering radio communication facilities includes objective testing of manufactured product samples to conformity to the requirements of the network or communication system, evaluation of manufacturer's capacity for a stable production of specified quality, etc. One particular feature of certification of radio communication facilities is determination of electronic compatibility of a manufactured product. The other important certification area is testing of its safety. A legislation is developed in the Russian Federation for compulsory certification. Russian State Standard (GOSSTANDART) developed the norm documents: "Certification System GOST" and " Certification System of Electrical Equipment to Conformity with Safety Standards". Procedures of issuing the certification, and authorizing agencies and their responsibility are discussed.

Independent Radio Broadcasting in Moscow

937K0240C Moscow RADIO in Russian No 6, Jun 93 p 5

[Article by A. Orlov]

[Abstract] More than twenty independent radio stations are operating in Moscow at the present time. They are music and information radio stations broadcasting in the middle-wave and ultra-short wave range. A list of Moscow independent radio broadcasting stations is provided in this article, which includes their addresses and telephones, as well as frequencies of broadcast. Among relatively new radio stations, the radio station "Tsentr" is worthy of attention. Its musical program is very diverse. Radio amateurs and users of personal computers would be interested in broadcasts on computers, and for the long distance listeners the "Tsentr" is planning to organize a DX-program. The radio station "Ala" is not included in the list because at the present time it is not broadcasting.

Gonets Global Communication System

937K0210A Moscow RADIO in Russian No 4, Apr 93 pp 2-3, 17

[Interview by RADIO correspondent A. Grif with Aleksandr Alekseyevich Kiselev, president of Smolsat Interbranch Economic Association, and Vladimir Nikolayevich Vlasov, chief designer of Gonets system]

[Abstract] The Gonets global communication system will be a system of 36 satellites in six bands (six satellites each) in a low polar near-circular orbit with an inclination of 83° and three types of ground-based transceiving stations (differing in size). The system is intended for the exchange of digital messages. Two satellites are already in place. There are plans to launch six more satellites during 1993. The Gonets system will primarily serve banks and brokerages, but will also be used for environmental protection, geology, meteorology, rescue, medicine, and agriculture in areas without a well-developed communication infrastructure. The satellites will be placed at an altitude of 1300-1500 km and include retranslators and on-board message storage facilities. The ground stations will transmit to the satellite at 312-315 MHz, and the satellite will transmit to the ground at 387-390 MHz. Messages can be transmitted at 4.8, 9.6, and 64 kilobits per second, depending on the ground station equipment. If the receiver of a message is not in the radio visibility zone, the message is stored on board the satellite until transmission can be completed. The ground and space systems will be gradually deployed during 1994-1996, and will accommodate 1,000,000 users. Figures 2.

Enhancing, Expanding, and Connecting Peripherals to the Orion-128 PC

937K0210B Moscow RADIO in Russian No 4, Apr 93 pp 19-22

[Article by G. Rogov and M. Bridzhidi]

[Abstract] This article provides detailed instructions on the installation of expansion devices, enhancements, and connection of peripherals to the Orion-128 personal computer for radio enthusiasts. The article indicates important compatibility factors which must be considered when these devices are attached. In particular, the connection of a joystick and a printer are discussed. Figures 3; tables 4; references 8 (Russian).

Dacha Security System

937K0210C Moscow RADIO in Russian No 4, Apr 93 pp 34-35

[Article by A. Anufriyev, Chekov, Moscow Oblast]

[Abstract] This article provides details (including schematics) on how to build and install a security system which can be attached to the doors and windows of a building. Light and sound warnings will be emitted when a door or window is opened or when a line of the security system is cut. The operation of the circuitry in different scenarios is described, and specific parts used in the circuitry are indicated. Figures 2.

Effect of an External Magnetic Field on the Break-Down Process of the Superconducting State of a Combination Conductor

937K0248A St. Petersburg ZHURNAL TECHNICHESKOY FIZIKI in Russian Vol 63, No 1, Jan 93 pp 41-47

[Article by V. R. Romanovskiy, Kurchatov Institute of Nuclear Energy, Moscow]

[Abstract] This study deals with the fundamental features of superconductor's transition processes into a normal state when the magnetic field induction is varied. Stability of a combination superconductor, exposed to a specified magnetic field B and located in a cooling agent with temperature T_0, to finite temperature perturbations is examined. It is assumed that at the initial moment of time a finite section of the conductor is instantaneously heated to a temperature T_1, which is greater than the critical temperature of the composite for the given current. It is demonstrated that with increased induction of the magnetic field, the energy of tolerated perturbations is gradually decreased, and that the pulsed heat release and presence of an nonuniform magnetic field may cause a formation of stable resistive regions in the cooled superconducting magnetic systems. Feasibility of a complete absence of steady state regions of cooled magnetic systems is demonstrated. States are detected where a stable normal zone can exist in a uniform conductor. Figures 4, references 7: 4 Russian, 3 Western.

The Estimates of Time Stability of Optical Systems

937K0248B St. Petersburg ZHURNAL TECHNICHESKOY FIZIKI in Russian Vol 63, No 1, Jan 93 pp 48-53

[Article by A. R. Kuznetsov, R. I. Kuznetsov, Institute of Metal Physics, Ekaterinburg]

[Abstract] Creepage of ion crystals under weak stresses is computed based on a model of a very viscous fluid. Time stability of an optical system is estimated using a gas laser as an example. The time stability is the time during which the optical system retains its parameters at a specified level. A relatively simple case is examined here, where the optical system remains at a constant temperature, and the stress of an optical component is determined by its weight and pressure differential. Stability of an optical system under impact of an external source of ionizing radiation is also discussed. It is demonstrated that the time stability of an optical system is determined by the internal structure of materials (size, boundary thickness, etc) and the external impacts (temperature, radiation situation, etc). The time stability of an optical system can be predicted by taking into account these factors, and based on the considerations which are described here, the optical materials can be selected for the particular operating conditions. Table 1, references 8 Russian.

Phase Non-Reciprocity in a Fiberoptical Ring Interferometer With an Imperfect Space Filter

937K0248C St. Petersburg ZHURNAL TECHNICHESKOY FIZIKI in Russian Vol 63, No 1, Jan 93 pp 116-121

[Article by A. Ts. Andreyev, V. D. Vasilyev, V. A. Kozlov, R. L. Shubochkin, Institute of General Physics, Moscow]

[Abstract] The effect of waveguide properties of single-mode fiber-optics lightguides (FOLG), used in a fiber-optics ring interferometer (FORI) for spatial radiation filtering, on the value of phase non-reciprocity in this interferometer was experimentally investigated in this study. A block diagram of the experimental set-up is provided and the measurement procedures are described. Radiation from a multimode semiconductor laser (λ=835 nm) was applied to the spatial filter of the interferometer made of from one to two meter long sections of different single-mode FOLG. Comparative experimental studies of three types of fiber-optics phase modulators in a ring interferometer with a polarized and de-polarized radiation were performed. It was demonstrated that a non-optimal selection in the FORI of the radiation source wavelength with respect to the cut-off wavelength used with the single-mode FOLG, as well as a insufficient suppression of the envelope modes in the filter waveguide may produce significant parasitic phase shifting in the ring interferometers. Figures 5, references 6: 1 Russian, 5 Western.

Combination Switching of Optical Channels 2 x 2

937K0248D St. Petersburg ZHURNAL TECHNICHESKOY FIZIKI in Russian Vol 63, No 1, Jan 93 pp 180-183

[Article by V. M. Kotov, Institute of Radio Engineering and Electronics, Fryazinsk]

[Abstract] Acousto-optical 2 x 2 switches, employing anisotropic as well as isotropic light diffraction (combination switching of optical channels) were examined in this study, and experiments were performed on switching the optical channels. A TeO_2 monocrystal was used as an acousto-optical material with dimensions 8 x 8 x 10 mm along directions [110], [110] and [001] respectively. A $LiNbO_3$ piezo-transducer generating a shift wave in the shift direction along [110] with a frequency of about 20 MHz, was attached to the edge [110] and a 150 MHz longitudinal wave was generated along [110] by a piezotransducer made of identical material. The longitudinal wave velocity was v_L=4.66 x 10^5 cm/s, the transverse wave velocity was v_S= 0.6 x 10^5 cm/s. The anisotropic diffraction was carried out by the longitudinal wave, and the isotropic diffraction by the transverse wave. The real "decoupling" between channels was 40 dB, which is by 40 dB worse, than the theoretical. This can be explained by the effect of scattering within the crystal, by nonuniformities of the

acoustical and optical fields, etc. In general, the theoretical computations indicate that the proposed switching is superior, in some parameters, to the similar schemes proposed by other authors. Figures 2, references 5: 4 Russian, 1 Western.

Determination of Parameters of Regulator for Linear System on Basis of Frequency Criteria

937K0224A Moscow AVTOMATIKA I TELEMEKHANIKA in Russian No 5, May 93 manuscript received 16 Jun 92 pp 3-10

[Article by B.L. Bimbirekov, candidate of technical sciences, Moscow Experimental Design Office "Mars", Moscow; UDC 62-55:62-501.45]

[Abstract] Synthesis of a regulator for a linear system on the basis of frequency criteria is considered, the space of free parameters being for this purpose partitioned into regions of allowable dynamicity. The problem is first solved by using the amplitude stability margin ΔA and the phase stability margins ΔF as the frequency criteria of dynamicity. It is solved for a closed system $\Phi(p)= W(p)/[(1+ W(p)]$ where the transfer function of the open system $W(p)= S(p)k_1 + Q(p)k_2 + R(p)$ has only two free parameters $k_{1,2}$. The characteristic equation of such a system is $1+ W(p)= 0$ and the parametric equation of its stability boundary is $W(j\omega)= w$. The frequency criterion of dynamicity is formulated so as to ensure satisfactory transient process dynamics, which requires that the $W(j\omega)$ hodograph of the open system encircle the point $w= (-1,0)$ in accordance with Nyquist's criterion and pass through two points $w_{a,f}$ corresponding to the desired amplitude and phase stability margins respectively. This method of partition differs from classical D-partition in that the set of solutions to each individual equation is a line in the $(k_{1,2}$ plane, which lies within the stability region established by D-partition (Yu.I. Neymark, 1978), and that the solution to the system of equations $W(j\omega)= w_a$, $W(j\omega)= w_f$ is the point of intersection of the two equimargin lines. The problem is also solved by using the oscillatory response index (maximum ordinate of the amplitude characteristic of the closed system) as the frequency criterion of dynamicity. It is solved by this method specifically for a closed system with a transfer function of the open system $W(p)= S(p)k_1 + Q(p)k_2 + G(p)k_3$ which has three free parameters $k_{1,2,3}$. In order to ensure satisfactory transient process dynamics in this case, it is necessary that the $W(j\omega)$ hodograph of the open system encircle the point $w(-1,0)$ in accordance with Nyquist's criterion and pass through the two points $w_1= (a_1, b_1, w_2= (a_2,b_2$ at slopes c_1, c_2 respectively. Each method of partition is demonstrated on a numerical example. Figures 6; references 6.

Predicting Technical State of Dynamic Systems on Basis of Renovative Kalman-Filter Sequence

937K0224B Moscow AVTOMATIKA I TELEMEKHANIKA in Russian No 5, May 93 (manuscript received 7 Jul 92) pp 163-167

[Article by Ch.M. Gadzhiyev, candidate of technical sciences, Azerbaijani Scientific-Industrial Association "Neftegazavtomat" (Petroleum-Gas Automation), Sumgait; UDC 681.51]

[Abstract] A method of predicting the technical state and especially failures of dynamic systems is outlined, namely by use of renovative sequences which under normal operating conditions represent white Gaussian noise with zero mean and unit covariance matrix in a Kalman filter. The method is demonstrated on a linear dynamic system describable by the discrete equation of state $y_i=$ transpose of $x_i(\theta)$ $(i= 1,2,...)$ and the discrete equation of readings $z_i= y_i + h_i$ (transpose of x_i- input signal at discrete instant of time i, (θ)- vector of system parameters, h_i - Gaussian random measurement error with zero mean and dispersion σ^2). The renovative sequence having been normalized so as to make its dispersion equal to unity and its distribution normal, the tolerance intervals for it are constructed and together with its given confidence intervals used for real-time failure prediction on the basis of the two-ellipsoid overlap test according to T.H. Kerr. The algorithm concludes with verification of the overlap of confidence interval $[u_1,u_2]$ and tolerance interval $[l_1,l_2]$, which requires that $u_2 \geq l_1$ and $l_2 \geq u_1$. When only one of these two conditions is not satisfied, then failure is possible. When both are satisfied, then the system is presumed to operate normally and calculations are repeated for the next instant of time. Following this algorithm in automatic control systems makes possible timely removal of faults and breaks in manufacturing equipment, timely replacement of sensors and servomechanisms, and rejection of false data. References 8.

Optically Induced Soliton Excitation in Soluble Polyacetylene

937K0223A Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 57 No 9-10, May 93 (manuscript received 25 Mar 93) pp 530-533

[Article by V. M. Kobryanskiy, Institute of Chemical Physics, 117977 Moscow, Russia; and T. A. Kulakov and D. Yu. Parashchuk, Physics Department of Moscow State University imeni M. V. Lomonosov, 119899 Moscow, Russia]

[Abstract] Soluble polyacetylene films were studied. Polyacetylene globules ranging from 150 to 300 angstroms in size were inserted into a polymer matrix. The polyacetylene concentration in the polyvinyl butyral matrix was three to five percent. Optical density of the film was about one. The experiments were conducted with polyacetylene films which had been aged after preparation over the course of a year and had been thermally isomerized into the transform at 473 K. Thickness of the polyacetylene film was 6 micrometers. The film was inserted between two sapphire substrates and placed in a vacuum nitrogen cryostat with temperature regulation in the range from 100 to 300 K. The photoinduced absorption spectra were measured at heavy band excitation by radiation of a He-Ne laser with an intensity up to 400 MW/cm^2. The photoinduced absorption spectra and polyacetylene absorption were recorded by using a monochromator illuminated by a halogen incandescent lamp. The signal from the silicon photodetector was measured by a quadrature, synchronous detector with mechanical pump beam modulation in the frequency range from 10 to 10^2 Hz. Solitons observed were mainly neutral compared to the charged previously observed. Neutral soliton states were recorded for the first time at room temperatures. Figures 2; references 10 Western.

Anisotropy of Electron g-Factor in GaAs/AlGaAs Asymmetric Quantum Well

937K0223B Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 57 No 9-10, May 93 (manuscript received 30 Mar 93) pp 557-560

[Article by V. K. Kalevich and V. L. Korenev, Physico-Technical Institute imeni A. F. Ioffe, 194021 Saint Petersburg, Russia]

[Abstract] In an asymmetric quantum well, grown from semiconductors with the structure of zinc blend in the z direction, spinal cleavage of the conductivity zone caused by the absence of the center of inversion led to conductivity electron g-factor anisotropy in the well plane. The example of a GaAs/AlGaAs quantum well was used to demonstrate that the nondiagonal components, which characterize the electron g-factor anisotropy in the well plane, may be commensurate in value to the diagonal components. References 11: 7 Russian, 4 Western.

Asymmetric Nanostructure in Magnetic Field

937K0223C Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 57 No 9-10, May 93 (manuscript received 1 Apr 93) pp 565-569

[Article by A. A. Gorbatsevich, Moscow Institute of Electronic Engineering, 103498 Moscow, Russia; and V. V. Kapayev and Yu. V. Kopayev, Physics Institute imeni P. N. Lebedev, Russian Academy of Sciences, 117924 Moscow, Russia]

[Abstract] An asymmetric system of quantum wells in a magnetic field paralliel to the layers was found to have anomalously large photogalvanic and magnetic-electrical effects. These macroscopic effects at the microscopic level were caused by the formation of asymmetry of the spectrum of quasi-particles from the quasi-momentum which in turn indicated the presence of non-zero toroidal moment density in the system. A sharp redislocation of electrons between wells was found possible in crossed electrical and magnetic fields. Figures 3; references 7: 5 Russian, 2 Western.

On the Possibility of High-Temperature Superconductivity Based on Coulomb Mechanisms of Cooper Pairing of Current Carriers

937K0223D Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 57 No 9-10, May 93 (manuscript received 23 Mar 93) pp 629-633

[Article by E. A. Pashitskiy, Institute of Physics, Ukrainian Academy of Sciences, 252650 Kiev, Ukraine]

[Abstract] Anderson's statement on the impossibility of obtaining high critical temperatures in superconductors by using non-phonon (Coulomb) mechanisms of Cooper pairing in the general case was found to be incorrect. Local field effects produce an increase in the charge of the quasi-particles. This almost fully compensates for the decrease in the inter-electron attraction and allows obtaining critical temperatures above 100 K. This conclusion is also contrary to the concept of negative values of static dielectric permittivity previously reported by others. References 22: 12 Russian, 10 Western.

Electromagnetic Wave Diffraction by Edges of Buildings and Structures

937K0216A Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 38 No 5, May 93 pp 789-803

[Article by A. V. Sokolov, I. G. Yarmakhov; UDC 538.574.6]

[Abstract] This article deals with diffraction of the centimeter and millimeter radio waves by wall edges of buildings and also by surfaces which have a discontinuity of the physical parameters. Unlike commonly used methods of geometrical optics, a smooth wedge model with a rounded edge exhibiting a finite or infinite conductivity is used in this study for the analysis of the diffraction field. Diffraction fields are shown in the graphs for E and H-polarization of the incident field, when the direction of the E or H vectors is parallel to the edge of a perfectly conducting wedge for various rounding curvatures of the edges. Figures 3, references 9: 7 Russian, 2 Western.

A Method for Determining the Complex Dielectric Permittivity and Magnetic Permeability of Radio Wave Absorbing Material

937K0216B Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 38 No 5, May 93 pp 814-818

[Article by S. M. Nesterov, I. A. Skorodumov; UDC 621.372.8]

[Abstract] A method is proposed for determining the complex permeability of radio waves absorbing materials (RWAM) ε, μ using a panoramic R2 type meter. This meter can provide measurements of the ε and μ in magnitude of a hundredth part to several hundred units in the wave-length range from 0.025 to 30 m. The essence of the proposed method lies in the following. In the first place, the measured relationship of the absolute value of the power reflection coefficient as a function of the sample thickness for a fixed wave length of the microwave signal, can be classified as an exponential type or an oscillating type relationship. In the second place, the reflection phenomenon in a coaxial line is not much different from a similar phenomenon occurring with a normal incidence of a planar wave on the interface of two media, which allows to employ an exact solution of the corresponding diffraction problem for computations. Results of the ε and μ measurements are provided using the proposed method and the short circuit method. This method can be employed for estimating the efficiency of RWAM in a wide frequency range, and also when synthesizing the RWAM and electronic materials with specified properties.

A Method for Detecting Anomalous Changes in the Characteristics of the Earth's Natural Field at Frequencies Between 0.1 and 30 kHz when Searching for Electromagnetic Indications of Impending Earthquakes

937K0216C Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 38 No 5, May 93 pp 845-852

[Article by A. A. Belyayev, L. T. Remizov, N. V. Tolstobrova, A. V. Elbakidze; UDC 537.266+621.391.821]

[Abstract] A methodology is developed for detecting, in a noise background, anticipated electromagnetic signs of impending earthquakes. This methodology is based on a simultaneous recording of the natural field of the Earth in the frequency ranges from 0.1...2 kHz and 3...30 kHz. The distinguishing features of the methods lie in that the anomaly of the field changes constitutes not only the field intensity, but the particular characteristics of its pulse structure as well. Based on the results of processing the measurement records of the field in a seismic zone, it was demonstrated that the probability of a false detection of the anticipated anomalies - precursors of earthquakes was by an order of magnitude smaller when the proposed algorithms and the methods were used, compared to measurements of only the intensity indicator of the pulse flow of the Earth's field. Figures 4, tables 2, references 8: 7 Russian, 1 Western.

The Effective Area of Scattering by the Earth Surface of Circularly Polarized Short Waves in the mm Range

937K0216D Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 38 No 5, May 93 pp 852-856

[Article by G. A. Andreyev, G. I. Khokhlov; UDC 621.391.81:621.371.029.65]

[Abstract] Results of measuring the effective area of scattering (EAS), by the Earth surface, of circularly polarized short waves in the millimeter range are described. Measurements were made of specific EAS of sandy and adjoining surfaces at grazing angles of θ = 2...4° and 40...90°, and also of a concrete surface at grazing angles of 18° and 21°. The experimental data for the sandy surface support theoretical computations of the EAS made by the tangential surface method for the range of angles equal to the half-width of the characteristic scattering curve. By comparing the experimental data with the theoretical, estimates were obtained of the rms angle and correlation radius of micro-irregularities of the sandy surface. Graphs are provided of the EAS of different surfaces for small grazing angles and for incident angles between zero and 50°. Figures 5, references 10: 9 Russian, 1 Western.

Generalization of a Space-Time Model of a Filter Made With a Charge-Coupled Device

937K0216E Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 38, No 5, May 93 pp 931-939

[Article by A. V. Bogoslovskiy; UDC 621.37]

[Abstract] A space-time model of a filter made with a charge-coupled device (CCD) is generalized, and equations are obtained describing the filter performance in different operating modes. It is demonstrated that only three alternate ways are possible for the model implementation: a discrete, a continuous, and a continuous in time and discrete in space. The discrete model of the filter is a most general model which allows to obtain all possible particular cases by applying appropriate limiting transitions. Direct and inverse discrete transformations are obtained which can be significant for the synthesis of digital computing media. Figures 5, references 3 Russian.

Neurocomputer Logic Circuit Design Using XC2000 Logic Cell Arrays

937K0232A Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 1, Jan-Feb 93 (manuscript received 21 Jul 92) pp 9-15

[Article by Stanislav Sergeyevich Zabara, doctor of engineering sciences, Eduard Ignatyevich Komukhayev, candidate of engineering sciences, Mikhail Ernstovich Kussul, doctor of engineering sciences, and Vladislav Georgiyevich Sakharin, candidate of engineering sciences; all from the Institute of Cybernetics, Ukrainian Academy of Sciences (Kiev); UDC 681.3]

[Abstract] Problems of design of logic circuits using XC2000 logic cell arrays were discussed. Used as an example was the development of a neurocomputer implemented as a coprocessor board connected to the system bus of an IBM AT PC. This allowed increasing the scope of neuron networks modeled and the processing rate. In the circuit built, cycle execution time did not exceed 3.2 microseconds. The XC3000 and XC4000 arrays offer higher processing rates. The block diagram and algorithm for operation of the neurocomputer were illustrated. The main logic nodes were described. Telephone Kiev 266-37-83 for further information. Figures 3, references 3 Russian.

Implementation of the Capability of Ideal Easy Testing of Logic Circuits

937K0232B Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 1, Jan-Feb 93 (manuscript received 30 Sep 91, after revision 4 Feb 93) pp 15-26

[Article by Nikolay Dmitriyevich Stukach, scientific associate, Institute of Cybernetics, Ukrainian Academy of Sciences (Kiev); UDC 621.382:681.14-32]

[Abstract] A method for synthesis of a arbitrary abstract finite automata circuit was proposed. The circuit has the capability of ideal easy testing for practically all failures typical for the period of operation. This test does not require disconnection of nondiagnostic circuit inputs from working signal sources. It consists of checking the flow of a single pulse from a single diagnostic input to a single diagnostic output. The circuit was called an ideal long flip-flop since it was based on and its properties determined by a long flip-flop formed by three gates and their interconnections. Telephone Kiev 441-83-71 for further information. Figures 9; references 17 Russian.

Structural Methods of Raising the Energy Efficiency of Using CMOS Components in Digital Frequency Multipliers

937K0232C Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 1, Jan-Feb 93 (manuscript received 29 Apr 91, after revision 13 Jan 92) pp 34-44

[Article by Yuriy Nikolayevich Tsybin, engineer, Saint Petersburg; UDC 621.317.033]

[Abstract] Digital frequency multipliers were analyzed structurally with regard to the specifics of CMOS components. This analysis allowed establishing the possibility of adaptive reduction of power consumed by a digital frequency multiplier through reconfiguration of the structure of the base model taking into account the energy specifics of the CMOS component base. Efficiency was improved by eliminating the redundant precision of the base model in the low-frequency range of the input signal according to the principle of general intercommunication of characteristics. In the process, there was no increase in error compared to the base model. Analysis of two hardware implementations of the digital frequency multiplier with improved efficiency showed the matrix switches, the larger one, consumed less power in general than the register block for division, the smaller one, due to the increase in functional load on the components in the latter. The studies indicated that up to 55 percent of base object power consumption can be reduced in the low frequency range of the input signal with less than 10 percent increase in power consumption in the high-frequency range of the input signal. Telephone Saint Petersburg 255-04-45 for further information. Figures 5; references 15 Russian.

Hardware Monitor Based on Personal Computer for Experimental Study of Computer System Efficiency

937K0232C Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 1, Jan-Feb 93 (manuscript received 12 May 91, after revision 10 Aug 92) pp 92-96

[Article by Viktor Aleksandrovich Kurchidis, doctor of engineering sciences, Aleksandr Ivanovich Obrosov, candidate of engineering sciences, and Valeriy Petrovich Volchenkov, engineer; all of the IPVT, Russian Academy of Sciences (Yaroslavl); UDC 621.317.033]

[Abstract] A hardware monitor for studying the characteristics of computer system operations was built using a personal computer with a 286 processor, 1 MB of RAM, the MS-DOS 3.3 operating system and boards allowing 16 connections. The monitor was interfaced to a breadboard model of a system module for a recursive vector-flow system under development at the IPVT. The system module included arithmetic, control and switch processors and local memory built with 1804 and 1531 microcircuits. The clock rate was 15 MHz. Memory capacity was 64K words with 32 bits per word. Multiplication of two matrices was used as the computer load. The sampling interval ranged from 5 to 10 ms. The experiment duration ranged from 3 minutes to 1 hour. Device load profiles indicated that the devices were used together only half of the time (53 percent); the rest of the time, the devices were either free or operated without overlaps in time. Telephone Yaroslavl 11-72-43 or 11-38-21 for further information. Figures 3; references 5 Russian.

Towards the Issue of Interference Suppression in High Frequency Communications Channels for Electric Locomotive Haulage in Mining

937K0215A Moscow ELEKTROTOKHNIKA in Russian No 5, May 93 pp 21-23

[Article by O. N. Sinchuk, N. M. Artashevich, E. S. Guzov; UDC 621.391.82:621.335.3]

[Abstract] The way interference is formed in high frequency channels for electric locomotive haulage in mining is examined when system isolation pulse control devices are functioning. Several methods to suppress pulse interference and protect against interference in high frequency communication channels are proposed, as well as a design solution to these problems. The main functional capabilities of the device which has been developed are described. Figures 4; references 4 (Russian).

Vibration Damping Bearing Assembly for a Special Asynchronous Motor

937K0215B Moscow ELEKTROTEKHNIKA in Russian No 5, May 93, pp 40-44

[Article by V. I. Orlov, Yu. P. Povstyanoy, M. M. Yakovlev, T. S. Yurgenson; UDC 621.313.333.752]

[Abstract] In order to decrease the amount of noise and vibrations in asynchronous motors, a unique bearing assembly has been developed for special asynchronous engines (those which have an explosion proof design and are resistant to chemicals and the penetration of gases). The original design of this bearing assembly with a passive damper built into the end shield permits the vibrational acoustic characteristics to be markedly improved while preserving the existing process production level for asynchronous motors. Other advantages and disadvantages to such a design are also described. Figures 7; tables 1; references 5 (Russian).

Currents Passing Through Surge Arrestors When Lightning Strikes Power Transmission Line Supports

937K0215C Moscow ELEKTROTEKHNIKA in Russian No 5, May 93 pp 50-54

[Article by U. Vey-Khan, Kh. Tszin-Lyan; UDC 621.316.937.001.24]

[Abstract] The various applications for surge arrestors on transmission lines are discussed. The article is devoted to calculating the passing current and the absorption energy of surge arrestors when lighting strikes the line supports. The current passing through the surge arrestor is analyzed when lighting bursts into the line through the ground wire. Calculations show that installing surge arrestors on transmission lines doubles or triples the line's surge-proof current. Figures 3; tables 5; references 6 (1 Russian, 5 Western).

Studying the Formation and Annealing of Radiation Defects in Power Semiconductor Devices When Irradiated by Electrons

937K0215D Moscow ELEKTROTEKHNIKA in Russian No 5, May 93 pp 60-63

[Article by V. N. Arinushkin, E. M. Geyfman, A. D. Remenyuk, M. G. Tolstobrov, V. V. Chibirkin; UDC 621.382.026.001.5]

[Abstract] Radiation defect spectra in *n*-silicon are studied and compared when it is irradiated by monoenergic electrons and electrons from an industrial electron source with a continuous energy spectrum. Groups of sixteen diodes were subjected to irradiation by both electron sources. Both before and after irradiation, and during the annealing process, the DLTS spectra were measured, as well as the lifetime of the minor charge carriers by using the Lax method. The technique for measuring the DLTS spectra is given. The study shows that the resultant radiation defects are independent of whether the diodes were irradiated with either the 4 MeV electrons or the electrons with the continuous energy spectrum. Figures 2; references 7 (5 Russian, 2 Western).

Propagation of a Two-Dimensional Optical Soliton in a Resonant Gas Medium

937K0241A Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 6, Jun 93 pp 1902-1913

[Article by V. V. Kozlov, E. Ye. Fradkin, St. Petersburg State University]

[Abstract] Coherent interaction of an ultra-short light pulse with a two-level medium having a homgeneneous as well as nonhomogeneous absorption line, is examined, taking into account the initial shift of the pulse carrier frequency to a side from the absorption center, and accounting for the transverse structure of the field. Maxwell-Bloch equations for the field amplitudes and polarization were employed as a starting point for examining the problem, assuming a radial symmetry. An approximation of slowly varying phases and amplitudes was used and a soliton solution of the system of equations was sought. A solution was obtained from the diffraction parameter for the field's phase and amplitude in the zero order of the perturbation theory, i.e. without examining the effect of the rays's intermixing in the beam. Field changes were also examined when the intermixing effect was included as a correction to the principal solution. In a real experimental situation the coherent light pulse dissipates energy as it moves in a resonant medium. Two aspects of the problem are examined: the rate of energy attenuation of a 2π-pulse in a form of a hyperbolic secant, and the pulse carrier frequency shift due to the finite time values of the longitudinal and transverse relaxation. A feasibility of existence of a three-dimensional soliton was demonstrated. References 17: 6 Russian, 11 Western.

Amplification of a Schroedinger Soliton in a Limited Frequency Band

937K0241B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 6, Jun 93 pp 1914-1930

[Article by A. V. Belinskiy, Moscow State University]

[Abstract] The process of nonlinear distribution of a fundamental optical soliton in fiber with a nonlinearity and losses to a third power is examined within the framework of adiabatic approximation. The losses are compensated by a periodic or distributed amplification, whose bandwidth is comparable to the width of the soliton spectrum. Analytic relationships are obtained which describe the evolution of dispersion of the pulse fluctuations and the position of the soliton's peak. It is demonstrated that if the width of the soliton's spectrum is approximately comparable to the amplification band, the pulse fluctuations of this soliton are comparable to its quantum uncertainty and the coordinates of the fundamental soliton propagating in a perfect nonlinear lightguide without losses. A correction of the Gordon-Haus quantum limit is performed taking into account the effect of drawing the soliton's carrying frequency under the amplification line. Figures 4, references 28: 16 Russian, 12 Western.

The Dynamics of a System with a Three-Spin Interaction, Induced by a Strong Radiofrequency Field

937K0241C Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 6, Jun 93 pp 2129-2141

[Article by V. Ye. Zobov, M. A. Popov, RAS Siberian Branch, Physics Institute]

[Abstract] Decay features of free precession with three-spin interactions are examined. A theoretical study is performed of the dynamics of the spin system with a Hamiltonian at an arbitrary angle. Changes of the relaxation properties of magnetization, orthogonal to the effective field, are investigated under conditions when the orientation of this field in the rotating coordinate system is changing. The relationship in the mean Hamiltonian of two-spin and tree-spin dipole-dipole interactions, due to this change, is also examined. The third and fourth moments of the spectrum of nuclear magnetic resonance (NMR) are obtained in the rotating coordinate system. Using this data, the decay of free precession is determined by applying the memory function method. The relationship of the features of this decay, observed in experiments under so called "magic angle" with the three-spin interaction is explained. Figures 3, references 23: 11 Russian, 12 Western.

Electromagnetic Oscillations in a Metal-Dielectric Periodic Structure

937K0241D Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 6, Jun 93 pp 2154-2162

[Article by N. G. Bebenin, RAS Ural Branch Institute of Metal Physics

[Abstract] Wave spectrum in a periodic medium, which is formed by alternating nonmagnetic metallic and dielectric layers is examined and its surface impedance is computed. The magnetic field is assumed to be zero. It is also assumed that the free path of the electrons is such, that an abnormal skin effect would be observed in the solid metal. Under these conditions the spectrum is determined by the scattering processes at the boundaries of the metallic layer, while the properties of these boundaries may be different due to particular features of the superlattice growing process. A transformation matrix relating the field value and its derivative at the beginning and end of a period is used for finding the wave spectrum. The transformation matrix is shown to be unimodular. When computing its elements, it was assumed that the electron's reflection from the boundary is either specular or diffusive, or either specular at one boundary and diffusive at the other. It was demonstrated

that with a small thickness of the metal layer, the electrodynamic properties of the examined periodic structure are determined not as much by the metal's purity, as by processes occurring at the boundaries and by the fact of restricted electron motion along the direction of the wave propagation. References 9: 5 Russian, 4 Western.

The Effect of Abnormal Amplification of Nanosecond Pulses in the Active Medium of CO_2-Laser

937K0239A Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 20 No 6, Jun 93 pp 525-526

[Article by V. I. Kovalev; UDC 621.373.826.038.823]

[Abstract] The results of studies on radiation enhancement features in a CO_2 transferred-electron amplifier (TEA), in combination with a wave front inversion (WFI) mirror which was developed in the Lebedev Physical Institute are discussed. A new effect is experimentally detected. It consists in amplification by a factor of 1.2-1.5 of unsaturated gain of a nanosecond pulse in the CO_2 TEA with counter-propagation of a weak quasi-stationary monochromatic radiation, whose intensity is significantly weaker than the radiation intensity of the nanosecond pulse. A block diagram of the experimental setup is provided. Two identical photo-ionization TEA CO_2 modules were used in tandem for amplification. The linear gain of the master oscillator generated pulse was 2.9+/-0.1 m^{-1}. The amplitude of pulses was registered by receivers employing the photon capture effect with a time resolution of about 1 ns. Figures 2, references 3 Russian.

Powerful IR Lasers on Junctions of XeI Atoms

937K0239B Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 20 No 6, Jun 93 pp 535-558

[Article by O. V. Sereda, V. F. Tarasenko, A. V. Fedenev, S. I. Yakovlenko; UDC 621.373.826.038.823]

[Abstract] Experimental and theoretical works which are mainly related to the active medium forming kinetic mechanisms are discussed in this review. An analysis is made of the generation characteristics and mechanisms for achieving inversion in xenon lasers applying most promising modes and pumping methods. Maximum radiation energy of 650 Joule was obtained in an Ar-Xe mixture by electron beam pumping, and maximum efficiency of 3-5 percent by electron beam pumping, as well as by combination (Raman) pumping. The spectral structure of generation depends on the composition and pressure of the operating mixture and also on the power and duration of the pumping pulse. The greatest gain and least generation threshold were obtained with λ=2.65 and 2.03 μm, and the largest radiation energy with λ=1.73 μm. Experimental equipment which is used for laser generation is examined, and generation characteristics of electron beam pumping by millisecond, microsecond and nanosecond electron beams are discussed. Figures 22, tables 4, references 109: 59 Russian, 50 Western.

Two-Quantum Raman Type Processes in a Super-Expansion of Powerful Ultra-Short Light Pulses

937K0239C Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 20 No 6, Jun 93 pp 577-580

[Article by E. M. Belenov, I. P. Prokopovich; UDC 621.373.826]

[Abstract] Dynamics of a powerful electromagnetic pulse spectrum during coherent two-quantum combination type (Raman) interaction with medium, is examined when the approximation of slowly varying envelopes of the field and polarization is not valid. Existence of power threshold is demonstrated, when frequencies Ω are captured by the field spectrum (where $h\Omega = E_2 - E_1$ is the difference between energies participating in the simulated Raman scattering levels), a strong self-expansion occurs of the field spectrum. The results of theoretical study well agree with the experimental data on generation of super-continuum in different media, particularly on self-transformation of the spectrum of optical solitons in lightguides. Figures 2, references 25: 8 Russian, 17 Western.

The Dynamics of Super-Radiation in an Optical Cavity

937K0239D Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 20 No 6, Jun 93 pp 581-585

[Article by A. V. Andreyev; UDC 535.417.2]

[Abstract] This study deals with the dynamics of extended polyatomic systems in an optical cavity. Based on the analysis of a general (unabbreviated) system of Maxwell-Bloch equations, expressions are obtained for polar and azimuth angles of the local Bloch vector; a general form of the field phase and polarization is determined for a two-wave case, along with the conditions of the atom system decay at a maximum rate. Expressions for the system dynamics in approximation of slowly varying amplitudes and expressions for the Bloch angle in a general case are derived. The case of a collective super-radiation, i.e radiation decay at a maximum rate is examined, the form of the collective super-radiation pulse and the distribution type of the interference field, polarization waves and population inversion in the sample are determined. The feasibility of an experimental study of the effect is discussed. References 9: 6 Russian, 3 Western.

Simulation of Vulnerability of Insulated and Grounded Objects to Lightning

937K0225A Moscow PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 19 No 6, Mar 93 (manuscript received 17 Feb 93) pp 25-29

[Article by N. I. Petrov and G. N. Petrova]

[Abstract] Determination of the probability characteristics of vulnerability of objects to lightning solely on the basis of laboratory tests is inadequate. There is a need for computation models making possible simulation of a wide range of variations in parameters and requiring lesser time and material expenditures. A mathematical model is proposed which makes it possible to compute the probabilities of damage to insulated and grounded objects and the probabilities of serious impact of discharges on protected objects. The model takes into account the influence of surges, polarity of the effective voltage, geometry of the discharge gap and object, randomness of the trajectory of propagation of the leader and return discharge from the objects. The method is based on application of the theory of fractals for simulating the trajectory of propagation of the leader discharge in a discharge gap with allowance for other pertinent factors, a method used earlier in simulating intracloud lightning discharges. The results are of practical interest and can be used in simulating the vulnerability of flightcraft and surface objects (such as oil storage facilities, power transmission lines and substations) to lightning, in particular, when determining the height of orientation of lightning discharges and optimization of power transmission line parameters. Figures 2; references 12: 9 Russian, 3 Western.

Fiber Optic Pickups With Nonlinear Frequency Modulation of Optical Carrier

937K0225B Moscow PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 19 No 6, Mar 93 (manuscript received 26 Dec 92) pp 30-34

[Article by S. A. Yegorov, I. G. Likhachev, A. N. Mamayev and A. S. Polyantsev]

[Abstract] Some problems involved in the use of fiber optic pickups with linear frequency modulation of the optical carrier, used in measuring and monitoring various physical parameters, are examined. An interferometer is used as the fiber optic pickup sensing element and injection semiconductor lasers, a change in whose pumping current results in modulation of the lasing frequency, are used as the radiation sources. However the maximum amplitude of the linear frequency deviation in such cases does not exceed 50 GHz, which makes it difficult to process a radio signal because the minimum difference in the path of the rays in this case should be several centimeters and the requirements on modulation linearity are high, measurement times are long and the initial light frequency must be stabilized. Procedures are therefore proposed for overcoming these shortcomings. It is proposed that injection semiconductor lasers with nonlinear frequency modulation be used and that the signal be detected using a second interferometer. A block diagram of the proposed scheme is given and serves as a basis for a description of structure and functioning of the pickup. The efficient operation of such a fiber optic pickup is demonstrated. The removal of restrictions on the modulation law results in a considerable simplification of the laser power circuit and an increase in the maximum frequency deviation by almost an order of magnitude. The pickup output signal is determined only by the form of the interferometer spectral reflection function and is not dependent on light intensity fluctuations in the fiber optic channel. A method is proposed for processing the output signal which makes possible a considerable decrease in the influence of laser radiation parasitic frequency deviations. Figures 3; references: 4 Russian.

Use of Irradiation Technology for Fabrication of Magnetodiodes

937K0235A Alma-Ata DOKLADY AKADEMII NAUK RESPUBLIKI KAZAKHSTAN in Russian No 5, Oct 93 (manuscript received 7 Aug 92) pp 28-32

[Article by I.A. Karapatnitskiy and D,M. Mukhamedshina, Institute of Engineering Physics at Academy of Sciences of Kazakhstan Republic; UDC 621.382.6.011.222]

[Abstract] Magnetodiodes are novel semiconductor devices capable of sensing magnetic field intensity. Their base region is geometrically much longer than the diffusion path for excess charge carriers and, therefore, requires a high injection level. Most suitable materials for these devices are high-resistivity semiconductors such as p-Si with an electrical resistivity above 10 kΩ.cm. Introduction of radiative defects by bombardment with fast neutrons has been found to facilitate effective control and optimization of the performance parameters of these devices during the their fabrication. The voltage drop across the device and its sensitivity to magnetic field intensity, both depending on the ratio of base length to diffusion length, were thus already raised up to 12 V and above 30 V/T respectively by bombardment with an about 10^{11} cm^{-2} flux of $E > 3$ MeV neutrons and subsequent annealing at an about 150°C temperature for 1-3 h. In order to make the bombardment with fast neutrons more effective and thus allow a lower injection level, it is necessary to shorten the base region and correspondingly adjust the bulk lifetime of excess charge carriers. The underlying physical basis of this technology is the strong influence of the injection characteristics of junctions on their sensitivity to magnetic field intensity. Lowering the injection coefficient changes the electric field distribution in the base region and, particularly, raises its intensity near the corresponding junction. The parameters of semiconductor diodes with a geometrically d= 0.6 mm long base region were successfully controlled by bombardment of the p^+-p region with α-particles, the voltage across the device having thus been raised to a three times higher one. Inasmuch as such a treatment produces inevitably some defects which remain unstable even at room temperature, stabilizing heat treatment preferably at temperatures within the 200-220°C range for 2-3 h is required. Figures 3; references 7.

Geological Problems With Kazakhstan's Gold

937K0235B Alma-Ata DOKLADY AKADEMII NAUK RESPUBLIKI KAZAKHSTAN in Russian No 5, Oct 93 (manuscript received 20 Aug 92) pp 47-54

[Article by T.M. Zhautikov and L.G. Nikolayev, Institute of Geological Sciences imeni K.I. Satpayev at Academy of Sciences of Kazakhstan Republic]

[Abstract] Kazakhstan's gold reserves have been playing an important role in the republic's economy and will do so especially during the period of economic instability following dissolution the Soviet Union. The key problems here are: building up a gold reserve at this time and method of doing it, role of Kazakhstan' government in increasing that reserve, and finding the economic incentives for the necessary gold production output. It is proposed that a solution to these problems will be found after the relevant geological aspects have been considered. For this first the trends in gold mining worldwide are analyzed, with emphasis on Kazakhstan's relative position in terms of current and anticipated yield. Three examples are cited to demonstrate the effectiveness of estimating the potential gold yield from auriferous deposits by geological methods. The first example is the computation of the yield from large, medium-size, and small deposits by referring to data on already thoroughly evaluated ore regions worldwide. The second example are already discovered small gold-and-silver bearing veins in the Balkhashskiy-Iliyskiy volcanic-plutonic belt, a typical one in Taskora on the northern shore of Lake Balkhash, as well as similar veins found elsewhere in the world (Cripple Creek in Colorado, Pueblo Viejo in the Dominican Republic, Baguio in the Philippines). The third example are vastly gold-rich veins in paleozoic greenstone belts (Kalgoorlie in Australia, Homestake in South Dakota, Porcupine in Canada). These methods can be employed in Kazakhstan in search of three likely kinds of auriferous deposits: 1) auriferous quartzite deposits like those in Zell am Ziller, Austria; 2) mylonized granite and gneis deposits like those in Jungcheng, Shantung peninsula of China, 3) gold-and-platinum bearing of gabbroidal origin like those in Skaergrad, Greenland. Other gold-rich ores are known to copper porphyry and polymetallic pyrite deposits in Kazakhstan. There will be needed a rational organization of gold ore mining and gold extraction, this problem being aggravated by the quite tremendous variability of deposit morphology as well as by the lack of adequate machinery ensuring economical and stable highly mechanized underground operations, segregation of ores, and their appropriate subsequent selective treatment. There will also be a need to modernize the ore processing technology so as to ensure the maximum possible yield of pure gold even from poor ores in an economical and ecologically clean manner. Proposals pertaining to this problem include utilization of otherwise not commercially valuable hard to separate sulfide ores, combining gravitational methods with hydrometallurgical ones and bacterial decomposition, replacement of amalgamation and cyaniding with glomeroblastic lixiviation. It will be furthermore necessary to provide flexible and transportable equipment for use in the many small gold mines. Tables 1.

Function of Radial Electrostatic Field in Coaxial Gyroklystrons

937K0238A Minsk VESTSI AKADEMII NAVUK BELARUSI, SERIYA: FIZIKA-TEKHNICHESKIKH NAVUK in Russian No 1, Jan-Feb 93 (manuscript received 21 Oct 91) pp 75-77

[Article by A.A, Kurayev, Minsk Institute of Radio Engineering; UDC 621.385.624]

[Abstract] A coaxial gyroklystron is considered which features a drift tube with the coaxial shield insulated from the other electrodes by dielectric inserts so that it can be held at a different potential. The electron gun of the magnetron type forms and injects a tubular electron beam. Energy modulation of electrons takes place in the coaxial input cavity resonator, inside which a rotating H_{n11}-mode magnetic field has been set up by the external alternating-voltage source. The coaxial output cavity resonator is excited into rotating H_{n11}-mode oscillations. The electron beam passes through it to a collector matched to a coaxial output transformer. The external signal source applies a voltage between the drift tube shield and a coaxial insert at the same potential as both cavity resonators. A major undesirable and cumbersome feature in this device is the angular spread of electron velocity in the helical beam, which cannot be prevented except by bunching with an infinitely high phase velocity. Such a phase velocity is not attainable, owing to the finite lengths of the cavity resonators. Ensuring a high efficiency of operation requires, moreover, that the magnetic field is slightly weaker than a synchronous one. It is, however, possible to compensate the spread of relative electron phase due to the angular spread of electron velocity. A radial electrostatic field inside the drift tube will accomplish this. Such a field crossing the axial magnetic field will together with it cause the electron beam to rotate azimuthally. Calculations based on the theory of slightly relativistic gyrating-field devices in the quasi-planar approximation of electron rotation in crossed fields indicates that a radial electrostatic field will make possible complete compensation of the velocity spread in electron beams with large pitch factors. It will also, when the external voltage source is a modulating one, facilitate phase modulation of the amplified signal. Figures 1; references 2.

Synthesis of Optimal Control in Discrete Problem With Limited Prediction of Opponent's Action

937K0238B Minsk VESTSI AKADEMII NAVUK BELARUSI, SERIYA: FIZIKA-TEKHNICHESKIYE NAVUK in Russian No 1, Jan-Feb 93 (manuscript received 13 May 91) pp 102-107

[Article by B.A. Knysh, Byelarusian State University; UDC 519.852.35: 853.4]

[Abstract] In the discrete system $x(t+1) = Ax(t) + bu(t) + dv(t)$ controlled by two adversary players time t is in the domain $T(t_*) = [t_*, t_*+1,...,t^*-1]$, $x(t_*) = x_0$, $x(t)$ in space R^n denotes the state of the system at time t, both d and b are in space R_n, u(t) and v(t) are the scalar controls of the two players, and A in space $R_{n\ x\ n}$ has a nonzero determinant. The game is played under conditions that the second at every instant of time τ the second player design a strategy, i.e., a program of control actions v(t) covering only a finite number j of subsequent instants of time. An optimum regulator is synthesized for the first player, assuming that for every opponent's control $v_\tau(.)$ admissible at instant of time τ there exists a first player's control $u_\tau(.)$ admissible at this instant of time. At the next instant of time τ+ 1 the first player knows both his and the opponent's optimal support controls $[(u_\tau;v_\tau)(.), T_{opt\ u;v}(u;v)]$ as well as the set of his optimal supports $S_{u,\tau}$ and the packet of the opponent's optimal supports $S_{v,\tau}$. The regulator must first eliminate the perturbation of both control u(t) and control v(t) corrections, then generate a new opponent's control which will be optimal as will be his control at the subsequent instant of time τ+ 1. The algorithm of this regulator consist of 18 steps with one iteration loop and yields optimal position control for the first player under given constraints on his opponent's strategy. References 1.

Powerful Shock Waves and the Extreme States of Matter

937K0237A Moscow USPEKHI FIZICHESKIKH NAUK in Russian Vol 163 No 5, May 93 pp 1-34

[Article by Ye. N. Avrorin, B. K. Vodolaga, V. A. Simonenko, V. Ye. Fortov, Russian Scientific Research Center "Chelyabinsk- 70", Russian Academy of Sciences Scientific Research Center for Thermal Physics of Pulsed Impacts]

[Abstract] The latest advances in studies dealing with physical properties of matter under ultra-high pressures and temperatures which are generated under compression and irreversible heating of solid bodies by powerful shock and thermal waves are reviewed. Experiments were conducted in the near zone of a nuclear explosion and also with chemical explosion devices employing the effects of geometrical and gradient cumulation. Methods of high-speed diagnostic and interpretation of dynamic experiments are described and the results of measuring the shock compressibility of materials under pressures of up to several thousand millions of atmospheres are provided. Theoretical models of strongly compressed plasma, in particular the role of the discrete spectrum in the plasma's thermodynamics, are analyzed. A comparison is made between models of imperfect plasma, and the role of phase anomalies and the quantum shell effects is analyzed. By recording the motion velocities of thermal waves, information is obtained about optical properties of hot plasma of condensed states. By recording the thermodynamic and radiation characteristics of plasma, obtained by adiabatic expansion of shock-compressed states, it was possible to advance into a difficult for the theory near-critical area of metals, where strong and complex interparticle interaction is taking place and the type of plasma statistic is changed. Figures 28, tables 4, references 155: 96 Russian, 59 Western.

Electronic Processes in Magnetite (Magnetic Mysteries)

937K0237B Moscow USPEKHI FIZICHESKIKH NAUK in Russian Vol 163 No 5, May 93 pp 53-66

[Article by K. P. Belov, Moscow State University]

[Abstract] In this review a new model of low temperature transformation in the magnetite is discussed. This model is developed, based on examination of the particular features of temperature and field relationships of spontaneous magnetization, magnetic resistance, and magneto-thermal effects, as well as the anomalies of magnetic anisotropy and magnetostriction due to electronic processes accompanied by the anomalies of the magnetization characteristic in the T_t region. This model agrees with the experimental data which did not fit the familiar Vervey model of "structure-electron" transformation. The experimental data exhibit: 1) A negative sharp increase of spontaneous magnetic saturation and maximum susceptibility of parmagnetic process when approaching T_t from high temperatures. 2) Anomalous (negative) sign of the magneto-thermal effect at T_t. 3) A smaller maximum of negative isotropic magnetic resistance at T_t compared to the one at temperature $T>T_t$. 4) A sharp increase of the constant of anisotropy when approaching T_t, and accompanying strong increase of magnetic susceptibility, coercive force and losses due to magnetic hysteresis. Figures 15, references 68: 35 Russia, 33 Western.

Light Scattering by Fluctuations of Electron Density in Many-Valey Semiconductors and Metals

937K0237C Moscow USPEKHI FIZICHESKIKH NAUK in Russian Vol 163 No 5, May 93 pp 67-114

[Article by B. Kh. Bayramov, V. A. Voytenko, I. P. Ipatova, St. Petersburg State Technical University]

[Abstract] Theoretical concepts of combination light scattering (CLS) by free current carriers in semiconductors and metals are reviewed. The CLS (Raman effect) profile is derived for a model of a zonal structure applicable for semiconductors and semimetals. Only a few energy zones are examined. Degeneration of the zones is taken into account in virtual as well as in the initial and final electron states. In a particular case of semiconductors with a simple conduction zone, such as nInP, GaAs, the CLS profile is obtained by determining the square of the classical electron radius. However, with large concentrations of charge carriers, this mechanism is suppressed by screening. Other CLS mechanisms are required for explanation of the spectrum and are also discussed here. Shape of the spectrum is computed for each of the scattering mechanisms; this required an examination of the kinetics of light scattering fluctuations. The available experimental data on the CLS are analyzed. Within the framework of effective mass approximation, the scattering mechanisms in semiconductors with supergratings and quantum wells are the same as in bulk materials. Directions are provided for application of the material discussed in this review in the case of electrons captured in the supergratings and wells. Metals and superconductors are also discussed. Figures 28, references 119: 52 Russian, 67 Western.

Absorption of Ultrasound in Superconductors with Electron-Hole Asymmetry

937K0236A Moscow SVERKHPROVODIMOST FIZIKA KHIMIYA TEKHNIKA in Russian Vol 6 No 2, Feb 93 pp 225-234

[Article by L. Z. Kon, I. P. Choban, Moldova Academy of Sciences, Institute of Applied Physics, Kishinev]

[Abstract] Sound propagation in superconductors in the presence of electron-hole asymmetry due to localized levels near the Fermi surface was examined. These levels can occur in a normal state as well as in a superconducting state. Mathematically, this asymmetry is manifested in the existence of an additional term in the scattering amplitude which describes the electrons' interaction with the impurities. The Anderson model is examined here (non-magnetic case), where a resonant electron scattering by localized impurity atoms is taking place. Quasi-particle and fluctuation contributions are computed. It is demonstrated that the fluctuation contribution to the attenuation coefficient (α_F) due to a slow relaxation of the parameter amplitude near T_c is different from zero in a linear approximation. Normally, with the electron-hole asymmetry, α_F is equal to zero in a linear approximation, therefore, in works of other authors, for obtaining different from zero values of α_F it was assumed that the asymmetry of the electron states density is near the Fermi surface. In the case which is examined here, the process of electron scattering by impurities is asymmetric in energy. The results of this study demonstrate that the Anderson model, which is used to describe systems with heavy fermions, satisfactorily explains the peaks of temperature dependence of the ultrasound absorption coefficient. Figures 2, references 25: 12 Russian, 13 Western.

Thermal Nonlinearity of a Superconducting Resonator

937K0236B Moscow SVERKHPROVODIMOST FIZIKA KHIMIYA TEKHNIKA in Russian Vol 6 No 2, Feb 93 pp 242-251

[Article by A. N. Reznik, A. I. Smirnov, M. D. Chernobrovtseva, Russian Academy of Sciences Institute of Applied Physics, Nizhniy Novgorod]

[Abstract] Effects of thermal nonlinearity on the static and dynamic characteristics of superconducting resonators are examined using as a model a unidimensional Fabri-Perot resonator consisting of two well-reflecting planar mirrors. The nonlinearity, due to the superconductor's heating by an electromagnetic field, was taken into account. A simultaneous solution of the equation

for a slowly changing complex amplitude of the field in a resonator filled by a non-dispersing medium and the thermal balance equation for a superconducting film on a thermally stabilized substrate was used for the analysis. A two-liquid model of a superconductor was used to compute absorption and reflection of the radiation by the field. A nonlinear frequency characteristic and a pulsed response was obtained as a function of the applied power. A good qualitative and quantitative agreement of the results with the available experimental demonstrates a usefulness of the proposed model. The effect of nonlinear amplitude oscillations of the field in a resonator can be used for developing an amplitude modulator of electromagnetic radiation. Figures 5, references 14: 5 Russian, 9 Western.

Methods for Studying the HF-Properties of Semiconductors

937K0236C Moscow SVERKHPROVODIMOST FIZIKA KHIMIYA TEKHNIKA in Russian Vol 6 No 2, Feb 93 pp 336-343

[Article by M. M. Gaydukov, V. L. Klimenko, A. B. Kozyrev, O. I. Soldatenkov, St. Petersburg Electrotechnical Institute, St. Petersburg]

[Abstract] A method is proposed for remote high-frequency measurements of the surface resistance of bulk and film superconducting samples using a spiral resonator at frequencies in the 25...250 MHz range. Using this method one can determine the surface resistance as a function of temperature R(T), as a function of the level of alternating hf field R(H), particularly the first critical field H_{c1}, or as a function of the permanent magnetic field. In order to examine the validity of the method, parameters of several superconducting materials: Nb, NbN, $YBa_2Cu_3O_{7-x}$ and Tl-Ba-Ca-Cu-O were measured, and the results are described. A resonator made of Nb was used at helium temperatures, and a copper resonator was used at other temperatures. The experimental results were in good agreement with the theoretical model, and indicate a linear relationship R(H) for fine films, and a quadratic for coarse-grained films. Figures 4, references 19: 6 Russian, 13 Western.

Fluctuations of Low-Frequency Voltages in Polycrystalline Superconducting Films

937K0236D Moscow SVERKHPROVODIMOST FIZIKA KHIMIYA TEKHNIKA in Russian Vol 6 No 2, Feb 93 pp 349-354

[Article by V. L. Bakumenko, Ye. D. Bekeshko, Scientific Production Association "Orion", Moscow]

[Abstract] The results of studying low-frequency fluctuation of voltages in polycrystalline films of high temperature superconductors are described. Sharp fluctuation peaks were recorded when the transport current exceeded the critical value. Depending on the voltage, these peaks form a characteristic pattern for a given sample, which is sensitive to the external effects (magnetic field and microwave radiation). Experimental relationships of the low-frequency voltage fluctuations from the constant voltage at the sample were obtained using a four-probe method with film bridge samples of high temperature superconductors $Bi_2Sr_aCaCu_2O_x$ at temperature of 4.2 K. The feasibility of employing the detected phenomenon to study the synchronization of Josephson junctions formed by boundaries between crystallites in polycrystalline films is discussed. Figures 4, references 4: 3 Russian, 1 Western.

Compressed States of Light and Control of the Radiation Wave Fronts Without Photon (Shot) Noise

937K0234A St. Petersburg OPTIKA I SPEKTROSKOPIYA in Russian Vol 73 No 6, Dec 92 pp 1158-1170

[Article by I. V. Sokolov, St Petersburg State University; UDC 535.2]

[Abstract] Physical properties of coherent optical radiation existing in a space-multimode compressed state are examined. Quantum fluctuations of the intensity of such radiation in time and space can be suppressed, which opens a theoretical feasibility for its application in obtaining low-noise optical images. Problems of generation, control, and detection of radiation without photon (shot) noise are discussed using a graphic illustration of the process of light field modulation in time and space. Behavior of the compressed light with free diffraction and in simple optical systems is also discussed. This study is based to a greater extend on a descriptive wave and quantum presentations than on exact theory. Figures 7, references 29: 5 Russian, 24 Western.

Dynamics of Shortening the Duration of Picosecond Garnet Laser Pulses With a Nonlinear-Optical Negative Feedback

937K0234B St. Petersburg OPTIKA I SPEKTROSKOPIYA in Russian Vol 73 No 6, Dec 92 pp 1171-1174

[Article by S. A. Bakhramov, O. R. Parpiyev, V. V. Tikhonenko, A. Yu. Ergashev, Department of Thermal Physics, Tashkent; UDC 535.23:621.373:535(206.1)]

[Abstract] Experimental results of the effects of nonlinear-optical negative feedback on the time characteristics of the generation of ultrashort YAG-Nd^{3+} laser pulses are discussed. The dynamics of shortening the duration of picosecond garnet laser pulses with a hybrid mode synchronization and a nonlinear negative feedback has never been examined before. The nonlinear feedback was produced by introducing a GaAs crystal into the resonator to obtain pulses with a spectrally-limited duration. A block diagram of the experimental setup is provided and experimental results on stretching the

generated pulse train and stabilizing its energy are discussed. It was demonstrated that a high stability of generated pulses, compared to stability of the parameters of continuous generators, can be achieved by introducing the nonlinear negative feedback into the resonator of a pulsed laser with a hybrid synchronization of the modes. Frequency tunable sub-picosecond ultrashort pulses with a pulse-train energy on the order of several microjoule were generated by a synchronous pumping of a dye laser using the described generator. Methods are proposed for optimizing the parameters of the generator of ultrashort pulses and its possible application. Figures 3, references 4: 3 Russian, 1 Western.

Optimal Processing of Signals Obtained by Synthesizing the Images of Small-Size Objects Using the Method of Active Interferometry

937K0234C St. Petersburg OPTIKA I SPEKTROSKOPIYA in Russian Vol 73, No 6, Dec 92 pp 1209-1214

[Article by A. L. Volpov, Yu. A. Zimin, V. N. Lopatkin, Scientific-Production Association "Astrofizika"; UDC 535.317.1]

[Abstract] The "super-resolution" problem in optics occuring when small-size remote objects are viewed through a turbulent atmosphere is examined in this paper. The problem is being solved by the method of active interferometry, applying statistical optimization of the recorded signal reflected from the object. Optimal estimates of the amplitude and phase of the object's image complex Fourier spectrum are obtained for the cases of its illumination through small apertures and apertures of an arbitrary dimension. In the former case it is sufficient to carry out a phase averaging of the recorded signal, but statistical signal processing is required in the latter case, when the object is illuminated by two adjacent wavelengths. References 5: 4 Russian, 1 Western.

Externally Excited Interferometer With an Absorbing Cell: The Resonance Shift of Saturated Absorption Due to Curvature of the Field's Wave-Front in the Resonator

937K0234D St. Petersburg OPTIKA I SPEKTROSKOPIYA in Russian Vol 73 No 6, Dec 92 pp 1215-1224

[Article by Ye. A. Titov, Russian Academy of Sciences Institute of Laser Physics, Novosibirsk; UDC 535.854]

[Abstract] Resonance shift of saturated absorption due to curvature of the field's wave front in the resonator, which is observed in a high-Q interferometer with an absorbing cell, is examined in this study. An absorbing OsO_4 cell, incorporated with a Fabry-Perot interferometer, which is excited by a CO_2-laser with λ=10.6 μm, is used as an example of this situation. The resonator is equipped with a plane mirror and a curved mirror, and the cell contains gas of two-level molecules interacting in resonance with the fundamental mode. Because of the standing wave front curvature, a term which is linearly dependent on the longitudinal coordinate is produced in the polarization, induced by this wave. Here, the polarization acts as a perturbation and causes changes in the longitudinal spatial field structure of the fundamental mode. It consists of a superposition of the resonator's longitudinal modes with coefficients which are proportional to the matrix elements of the perturbation, divided by the distance between modes. Along with the longitudinal nonuniformity due to the wave front curvature, a transverse nonuniformity is also produced due to absorption saturation. Figure 1, references 14: 8 Russian, 6 Western.

Resonance Interaction of Electromagnetic Waves and Surface Waves at Interface of Linear and Nonlinear Media: Excitation and Scattering

937K0233A Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 5, May 93 (manuscript received 19 Mar 92, revised version received 9 Feb 93) pp 1511-1526

[Article by A.A. Zharov and A.K. Kotov, Institute of Applied Physics at Russian Academy of Sciences]

[Abstract] Two affinitive phenomena occurring at the interface of a linear medium and a nonlinear one are examined, namely resonance excitation of p-polarized slightly nonlinear surface waves in the field of crossing electromagnetic beams and scattering of radiation by a surface wave of the same frequency. Both phenomena are due to scattering of incident waves by modulations of the refractive index of the nonlinear medium, modulations caused by interference of coherent incident wave fields. For the purpose of a self-consistent theoretical analysis, as the linear medium is considered vacuum (dielectric permittivity ε_0 occupying the lower half-space and as the nonlinear medium is considered one with a dielectric permittivity $\varepsilon_1 = \varepsilon_{10} + \alpha|E|^2$ (ε_{10}- quiescent dielectric permittivity, E- amplitude of electric field, α- nonlinearity coefficient positive for a focusing medium and negative for a defocusing medium). The excitation problem for surface electromagnetic waves in crossing electromagnetic beams (B_y- only component of magnetic field; E_x,E_z- only components of electric field) is solved when the characteristic width L_F of the two-beam crossing region is only slightly larger than the period of the two-beam interference pattern. This mode of excitation is shown to be a very efficient way of transforming volume waves into surface waves, not necessitating the use of complex optics. Existence of a transition layer at the interface may make the dispersion relation for these surface waves a nonmonotonic one and consequently cause two kinds of such surface waves to emerge: a forward one and a backward one, their frequencies being the same but their phase velocities and group velocities being opposite. The scattering problem is solved for scattering of volume electromagnetic waves by a surface

electromagnetic wave, on the basis of Maxwell's curl E and curl B equations for a nonhomogeneous and nonlinear medium. An equation of energy transfer from the incident volume wave to the scattered one is obtained by the method of second-order perturbation theory, energy transfer from the incident volume wave also to the surface wave giving rise to convective instability of the latter. Backscattering of a volume wave interfering with a symmetrically incident second one ($\theta_{1,2}$- their angles of incidence, $\sin\theta_2 = -\sin\theta_2$, $|\sin\theta_2| < 1$) can occur when its angle of incidence θ_1 is larger than some critical one which depends on the relation between its direction and that of the surface wave. The results of this analysis apply to interfaces containing a thin transition layer, in which case only the constant coefficients change. Figures 4; references 34.

Effects of Nonlinear Interaction of Ultrashort Pulses and Dielectric Paramagnetic Medium

937K0233B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 5, May 93 (manuscript received 21 Aug 92) pp 1527-1537

[Article by S.V. Sazonov and Ye.V. Trifonov, Institute of Pacific Oceanography at Far Eastern Division, Russian Academy of Sciences]

[Abstract] Interaction of a picosecond nanohertz magnetic video pulse and a dielectric paramagnetic material with an electron spin $s = ½$ is analyzed, assuming that the paramagnetism is due to the electron spin in the atomic S-state and that the external magnetic field of intensity H_0 causes a Zeeman split of this state into two sublevels separated by the frequency interval $\omega_0 = g_{\parallel}\beta_0 H_0/h^*$ ($g_{\parallel}$- component of Lande's tensor, β_0 - Bohr magneton, h^*- Planck's constant). A uniaxial paramagnetic crystal in a magnetic field parallel to its axis of symmetry and is considered and its Hamiltonian is formulated so as to include its interaction with a magnetic video pulse incident at an arbitrary angle. The system of equations of motion for an electron spin, i.e., for its three components of its velocity in Cartesian space coordinates is then obtained in the Heisenberg representation and combined with Maxwell's equations for a paramagnetic medium involving the pulse field vector (also the gradient of its divergence and its second-order partial derivative with respect to time) on the left-hand side and the concentration of paramagnetic atoms n on the right-hand side. The velocity of the pulse is then assumed to approach the speed of light. A circularly polarized steady magnetic pulse formed in such a medium and propagating parallel to the external magnetic field is considered, its longitudinal field component giving rise to a $\sin 2\delta$-term in the sine-Gordon equation and its transverse field component being the solution to that equation. As such a pulse passes through a paramagnetic medium under conditions of thermodynamic equilibrium, it rotates the electron spin in this medium through a complete 360° turn. When the initial state of the paramagnetic medium is off equilibrium (initial spin inversion $W_\infty < 0$) and $\lambda_{\parallel} = 4\pi\beta_0 nW_\infty/h^*\omega_0 > 1$, then there exists a "vacuum state" with a constant δ^* angle which minimizes the "Hamiltonian density" (δ^* corresponding to compensation of the static Zeeman split ψ_0 by the dynamic Zeeman effect produced by the longitudinal pulse field component). When $\lambda_{\parallel} < 1$ and dynamic inversion of the Zeeman sublevels is thus not possible, then a magnetic video pulse passing through a paramagnetic medium draws energy stored in the latter and thus becomes amplified while this medium returns to the ground state. When $\lambda_{\parallel} << 1$, then the $\sin 2\delta$-term drops out of the sine-Gordon equation so that both the pulse frequency and the intensity of the pulse field increase linearly along the pulse path. Inasmuch as the longitudinal component of the pulse field is responsible for circular polarization of the pulse, this component should impede its amplification. A process of interest in connection with nonlinear propagation of a magnetic video pulses is parametric frequency conversion associated with its passage through a paramagnetic medium. The solution to the original equations of motion for this case describes the effect of nutation in a superstrong magnetic field following superposition of slow rotation of the magnetic field vector in the equatorial plane of the Bloch sphere on rotation of the electron spin in the meridional plane of that sphere, as a result sum-frequency and difference-frequency components appearing in the spectrum of the output signal. Figures 2; references 18.

Electric Domains and Far-Infrared Radiation Emission in Uniaxially Deformed p-Ge Material

937K0223C Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 5, May 93 (manuscript received 13 Nov 92) pp 1829-1839

[Article by I.V. Altukhov, M.S. Kagan, K.A. Korolev, and V.P. Sinis, Institute of Radio Engineering and Electronics at Russian Academy of Sciences]

[Abstract] In an experiment p-Ge crystals were uniaxially compressed in the direction of a parallel electric field at a liquid-helium temperature, its object being to study first the effect of electric domains forming under voltage and pressure on spontaneous radiation emission and then the effect of strong-field domains on stimulated radiation emission. The nonuniformity of the electric field was monitored by a probe on the lateral surface of a crystal between the two main current electrodes: a galvanic probe during measurement of spontaneous radiation emission and a capacitive probe (0.5 mm thick metal foil separated from that surface by a mica sheet) during measurement of stimulated radiation emission. In an electric field of intensity within the NDC (negative differential conductivity) segment of the current-voltage characteristic of a homogeneous crystal there were, depending on the ratio of specimen length L to drift length $v\tau_M$ (v- velocity of charge carriers, τ_M- differential time of Maxwell relaxation), recorded either a moving strong-field domain with current fluctuations or a static domain with current saturation. The test results reveal

the dependence of the electric field intensity at the probe (referred to the distance from anode to probe) and of the current flowing through such a crystal on the applied voltage V over the 0-3.5 kV/cm range of V/L under various pressures within the P= 0-9 kbar range, also the dependence of the mean field intensity E at the anode on the pressure over the P= 0-9 kbar range at various applied voltages within the 0-3.5 kV/cm range. Spontaneous radiation emission from a p-Ge crystal with a static strong-field domain was recorded by Ge:Ga far-infrared detector (sensitivity range 80-120 μm wavelengths), its intensity having been found to increase first linearly with increasing applied voltage under pressures from about 4 kbar up. The beginning of this linear range evidently corresponds to radiation emission from outside that domain under all pressures above that threshold. Further increase of the voltage evidently causes radiation to be emitted mainly from that domain, the field intensity within the latter remaining constant inasmuch as its length also increases proportionally to the applied voltage. These trends were confirmed by measurements made with a Si:B photodetector sensitive to radiation within the visible and thus different range of the spectrum. Stimulated radiation emission from a p-Ge crystal began at a threshold pressure of approximately 9.5 kbar, a static strong-field domain forming at a voltage of approximately 400 V/cm and then widening as the voltage was increased. Under resonance conditions, moreover, its intensity increased steeply with increasing applied voltage and the field intensity at the probe as well as the current through the crystal changed. As the intensity of stimulated radiation emission increases, the current-voltage characteristic of a homogeneous specimen thus changes till eventually current jumps and radiation intensity jumps occur. The field then becomes uniform throughout the specimen, indicating that the domain has vanished. As the applied voltage was subsequently lowered, radiation emission continued and the field remained uniform. This hysteresis of stimulated radiation emission with respect to applied voltage was confirmed by a test involving application of a voltage pulse of a 1 μs duration so that its approximately 3.5 kV/cm magnitude, sufficient for stimulating a radiation emission, could be held constant during the first 0.3 μs and varied during the last 0.7 μs of its duration. In a crystal with a moving strong-field domain, with Gunn-effect current fluctuations, stimulated radiation emission was found to begin at an applied voltage lower than in a crystal with a static one. In crystals with extra-closely parallel faces stimulated radiation emission was found to begin already at a field intensity as low as the impurity breakdown level. Raising the applied voltage to the level of domain formation raised the intensity of stimulated radiation emission so high that domain formation did not occur. Stimulated radiation emission thus evidently can prevent instability of the domain kind in a compressed p-Ge crystal. The authors thank S. Komiyama and V.I. Gavrilenko for indicating that domain instability in deformed p-Ge material can strongly influence emission of far-infrared radiation, also N.G. Zhdanova for discussing the conclusions. Figures 7; references 9.

Anomalous Electromagnetic Waves in Crystal Near Nulls of Dielectric Permittivity

937K0233D Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 5, May 93 (manuscript received 9 Dec 92) pp 1840-1850

[Article by M.I. Ryazanov, Moscow Institute of Engineering Physics]

[Abstract] Propagation of plane electromagnetic waves through a crystal is analyzed, considering that in an anisotropic medium ideally without spatial dispersion all three components $\varepsilon_{x,y,z}$ in Cartesian coordinates are frequency-dependent and each becomes zero at a certain generally different frequency. Any two of these components, therefore, can have opposite algebraic signs within the range of frequencies between those at which each is zero. A specific case is a transparent crystal whose dielectric permittivity has a zero imaginary part within a wide range of optical frequencies from ω_1 to $\omega_2 >> >q_1$. Inasmuch as in macroscopic theory of electrodynamics a crystal is regarded as a homogeneous medium, all its molecules have accordingly the same orientation. On this premise is established a relation between the dielectric permittivity of such a crystal and the polarizability of its molecules, assuming its molecules to be axisymmetric with a length-to-width ratio > 1 and with a quantum energy smaller than their ionization potential so that the contribution of their inner electrons to their polarizability is negligible. The polarization P of such a crystal is then proportional to the mean local electric field E acting on its molecules. Next is considered existence of electromagnetic waves in real crystals with spatial dispersion. In uniaxial crystals, with a dielectric permittivity whose transverse ε_t and longitudinal ε_l components have opposite algebraic signs, extraordinary waves can exist within the frequency range between the two respective zero-permittivity frequencies. The dispersion relation for the wave vector of such waves indicates the ranges of angle δ between their wave vector k and the principal crystal axis within which nondecaying such waves can exist in a positive uniaxial crystal ($\varepsilon_l > \varepsilon_t$) and in a negative uniaxial crystal ($\varepsilon_l < \varepsilon_t$) depending on the relative absolute magnitudes of the two permittivity components. In a positive one they can exist over the full range of angle δ when $\varepsilon_t > 0$. In a negative one with $\varepsilon_t - \varepsilon_l > \varepsilon_t$ they can also exist over the full range of angle δ when $\varepsilon_t > 0$ and $\varepsilon_t - \varepsilon_l < \varepsilon_t$. In a negative one with $\varepsilon_t - \varepsilon_l > \varepsilon_t$ they can exist only when angle δ is larger or smaller than δ_c such that $\cos^2\delta = \varepsilon_t/(\varepsilon_l - \varepsilon_t)$ when $\varepsilon_t > 0$ or $\varepsilon_t < 0$ respectively. Slow extraordinary waves are more than ordinary ones sensitive to scattering by inhomogeneities and exist only within a narrow range of angle δ so that scattering easily pulls them out of this range and transforms them into ordinary ones. The existence of slow plane waves in a biaxial crystal is similarly determined by the dispersion relation for their wave vector k, namely

when $(kc/L\omega L)^2 >> 1$ (L- inverse of lattice constant, ω-frequency of wave, c- speed of light), and their characteristics are generally analogous to those of slow extraordinary ones in a uniaxial crystal. In an isotropic medium there cannot exist transverse plane waves of zero-permittivity frequency but there can exist a longitudinal plane wave with a wave vector such that $\varepsilon(\omega,k)= 0$. In a crystal with any one zero permittivity component plane waves can propagate but a transverse plane one cannot propagate in the direction of the zero-permittivity axis. This impossibility can lead to a peculiar situation for incident light: when the refracted plane longitudinal wave propagates in the direction forbidden to transverse ones, then an incident transverse wave will be totally reflected by the crystal. A small deviation of the incident plane wave from this direction will, however, allow propagation of also a refracted transverse wave through the crystal and thus result in dissipation of some incident energy by it. The author thanks D.B. Rogozkin for interesting comments. References 5.

Development Prospects of Holographic Measuring Systems

937K0231A Novosibirsk PRIBORY I SISTEMY UPRAVLENIYA in Russian No 5, May 93 pp 6-9

[Article by A. G. Kozachek, Yu. N. Solodkin; UDC 621.383:778.4]

[Abstract] Measurement methods which would make it possible to fully automate holographic measurement experiments and to expand the application of holographic interferometry are examined in this article. The holographic experiment consists of obtaining fringe patterns, converting the field of brightness into electric signals, computer processing, and decoding of the fringe patterns for delivering the obtained results to the user in a convenient form. A fully automated holographic measurement system for studying objects with a complex shape and for processing interference patterns of arbitrary configuration has been developed. A new approach based on representing the values in the residual class systems is used for decoding the holographic fringe patterns. An algorithm of the interference measurement process based on the integer method is described and its block diagram is provided. Elimination of the necessity of counting the interference bands for decoding the fringe patterns constitutes the principal distinguishing feature of the holographic measuring system employing the integer methods. Figures 5, references 4 Russian.

The Features and Development Prospects of Laser Systems for Automatic Control (Review)

937K0231B Novosibirsk PRIBORY I SISTEMY UPRAVLENIYA in Russian No 5, May 93 pp 9-11

[Article by I. D. Mitsenko; UDC 681.783.25]

[Abstract] Problems dealing with laser automatic control systems (ACS) and their design are examined. A short review is made of the results of earlier conducted theoretical and experimental works, and recommendations are provided for selecting the directions of further studies. Processes developing at the inputs of laser ACS are non-steady state. Therefore, an average probability of completing the task by the ACS is used as a main criterion. It was previously demonstrated that the criterion maximizing the probability of completing the task can be achieved using different adaptive algorithms. However, because of the non-steady state nature of the input processes, it is impossible in the short time of the signal and noise duration to determine their distribution density or their components. Variant-parametric adaptation methods are proposed which function under non-steady state conditions when the correlation time is limited. The essence of the method lies in that during operation the system changes its parameters, analyzes the environmental response, and based on this response under conditions of bimodal sampling makes a decision whether the input effect belongs to the useful signal, noise, or their additive combination. References 7 Russian.

Superconducting Magnetic Cardiograph

937K0231C Novosibirsk PRIBORY I SISTEMY UPRAVLENIYA in Russian No 5, May 93 pp 12-13

[Article by N. V. Golyshev, S. V. Motorin, B. M. Rogachevskiy, V. K. Beresnev, S. A. Perevozchikov; UDC 621.391.519]

[Abstract] A superconducting magnetic cardiograph was developed by the specialists of the Department of Information and Measurement Technology. The cardiograph is intended for use in a regular city clinic without special magnetic field screening chambers. Block diagram of the cardiograph is provided and fundamental technical characteristics are listed. Depending on the model, either radiofrequency SQUIDs with a high frequency bias, or dc SQUIDs with a dc bias can be used. The cardiograph operation is controlled by a personal IBM PC 286 type computer. The measurement results can be displayed on a screen, printer or a recorder. Programs are in the PASCAL language. They include programs for self tuning, electronic compensation of imbalance of gradient measuring antenna, control of tuning the amplification and conversion channel, display of measurements, service sub-programs, as well as programs for a graphic display of the measurements. The user oriented features of the cardiograph are significantly superior to foreign models, and the price and operating cost is much lower. Figures 1, table 1.

High-Temperature Superconducting High Frequency SQUID

937K0231D Novosibirsk PRIBORY I SISTEMY UPRAVLENIYA in Russian No 5, May 93 pp 15

[Article by N. I. Firsov, V. S. Shadrin, Ye. V. Ryabov, S. P. Khabarov, A. G. Golovnev; UDC 537.312.62]

[Abstract] Three types of high frequency SQUIDs made of high temperature superconducting ceramics were developed and mastered for a test production by the Department of Semiconductor and Quantum Electronics. This includes: a two-circuit gradiometer (Zimmerman design), a single circuit and a two-circuit magnetometer (Harvey design). The superconducting quantum interferometers are designed for application with standard SQUID equipment with a 15 MHz pumping frequency. Noise characteristics of the HF-SQUIDs at a temperature of 77 K in the white noise region are listed in a table. A typical value of the weak linkage at a place of a maximum thinning is between 30 to 50 micrometers. Because of a unique capacity of the quantum interferometers to register magnetic fields which are several million times weaker than the magnetic field of the Earth, an entire class of precision instruments can be developed for application in medicine, geology, archeology, etc. Figure 1, table 1.

Statistical Methods for Processing of Multidimensional Signals

937K0231E Novosibirsk PRIBORY I SISTEMY UPRAVLENIYA in Russian No 5, May 93 pp 16-17

[Article by T. B. Borukayev, A. A. Spektor, I. S. Gruzman, L. Ye. Deykhin; UDC 621.391.8:519.814]

[Abstract] A statistical approach to the solution of signal processing problems which depend on many independent variables is discussed. This type of signals describe images (individual frames), frame sequences etc. Many statistical image processing problems are formulated as filtering problems of multidimensional signals. The methods developed here are directed at a synthesis of the algorithms for filtering the recurrent structure which would provide an economical and efficient signal processing. A filtering problem of a n-dimensional gaussian signal in a gaussian noise with a dispersion σ^2 is examined applying a method of converging sequences of n-dimensional filters. Realization of a two-dimensional Wiener filer, which is normally used in the region of spatial frequencies requires a double application of a two-dimensional Fourier transform. With method proposed here this laborious operation is replaced by application of four one-dimensional filters realized in the case of Markov fields using simple recurrent procedures. The problem of objects detection with processing of multidimensional signals is also discussed. The approaches developed here are based on application of rank tests. The efficiency of rank tests is examined and the application of an adaptive rank algorithm for detection of linear objects is illustrated. Figures 2, references 2 Russian.

Plasmon Mechanism of High-Temperature Superconductivity in Cupric Metal-Oxide Compounds

937K0230A Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 3, Mar 93 (manuscript received 24 Feb 92) pp 867-909

[Article by E.A. Pashitskiy, Institute of Physics at Ukrainian Academy of Sciences]

[Abstract] The model of a laminate metal with two-dimensional (2D) partly overlapping filled wide band and narrow band near the Fermi level is shown to explain several extraordinary physical properties of cupric metal-oxide compounds. Five important of these properties being: 1) an anomalously high critical superconducting transition temperature, 2) an anomalously weak isotope effect with a power-law exponent which becomes smaller with higher critical temperature, 3) a nonmonotonic dependence of the critical temperature on both the concentration of doping impurity and the oxygen content (thus on both hole and electron concentrations in current-conducting CuO_2 layers), 4) a correlation between a higher critical temperature and more CuO_2 layers in the primitive crystal lattice, 5) a correlation between the maximum critical temperature and the frequencies of "oxygenic" vibration modes. The explanation of these and other properties is based on classical superconductivity theory in the approximation of medium-strong coupling in a quasi-2D two-band laminate metal with "light" (l) charge carriers (electrons) and "heavy" (h) charge carriers (holes), with an anisotropic spectrum of collective electron excitations which includes a low-frequency branch of acoustic plasmons (fluctuations of hole concentration with a quasi-acoustic dispersion relation). In the strong-coupling approximation, corresponding to holes almost completely localized in nodes of the crystal lattice and thus to a periodically nonuniform distribution of electron concentration, the spectrum of hole plasmons is a periodic function of the quasi-momentum with a period equal to that of the reciprocal lattice and thus analogous to the phonon spectrum. In this approximation, moreover, the spectrum of acoustic plasmons in a laminate metal with a 2D narrow band and a far-off-parabolic spectrum of hole plasmons is a periodic function of the transferred longitudinal momentum, hybridization of acoustic plasmons with LO and TO phonons taking place throughout the entire volume of the Brillouin zone so that attraction between electrons and their subsequent Cooper pairing takes place throughout the entire range of magnitudes of the transferred longitudinal momentum up to twice the Fermi momentum of degenerate electrons. On the assumption that acoustic plasmons in cupric metal-oxide compounds hybridize most effectively with the optical phonons which correspond to vibrations of O^{2-} ions in CuO_2 layers, a mathematical model of electron-plasmon interaction and electron-phonon interaction in laminate metal-oxide compounds is constructed accordingly. Into account is taken the experimentally established fact that

in cupric metal-oxide compounds of both $YBa_2Cu_3O_6$ and $Bi_2Sr_2CuO_6$ kinds the frequencies of those hybrid vibrations become higher upon transition from nonsuperconducting or low-temperature superconducting phases to high-temperature superconducting ones. An equation for the gap parameter is formulated and the role of electron-plasmon interaction depending on its strength relative to that of hole-plasmon interaction is evaluated on the basis of this model, considering also that a change of the composition or of the oxygen content leads to an either Hubbard or Mott dielectric-to-metal phase transition which almost coincides with transition to a high-temperature superconductor phase, and assuming that the Fermi level at the transition point lies very close to the edge of the 2D narrow band separated by a gap E_0 from the facing it edge of the 2D wide band. In the case of a medium-strong plasmon-hole coupling (coupling constant smaller than unity) the critical temperature is proportional to the plasmon-hole interaction frequency and an exponentially decaying function of the plasmon-hole coupling constant. In the case of strong plasmon-hole coupling (coupling constant much larger than unity) and of a critical temperature is much higher than the plasmon-hole interaction frequency, strong attenuation of quasi-particles is known to lead to a "gapless" state with zero complex gap parameter on the Fermi surface. On the basis of this model is also calculated the power-law exponent characterizing the isotopic shift of the critical temperature. The results of theoretical calculations are compared with experimental data pertaining to many cupric metal-oxide compounds: $YBa_2Cu_3O_7$ (three CuO_2 layers), $Bi_2Sr_2CaCu_2O_8$ (two CuO_2 layers), $Tl_2Ba_2Ca_2Cu_3O_{10}$ (three CuO_2 layers, recently synthesized $(Ca_{1-x}Sr_x)_{1-y}CuO_2$ with alternating CuO_2 and Ca(Sr) layers, multilayer Bi_2 and $Tl_mBa_2Ca_{n-1}Cu_nO_x$ (n layers). An analysis of the isotope effect relative to oxygen in these cupric metal-oxide compounds reveals that it becomes weaker as the critical temperature is raised, except in the $La_{2-x}Sr_xCuO_4$ class of compounds: here its power-law exponent anomalously first increases to an approximately 0.6 maximum as the Sr-content is increased to x= 0.16 and then decreases down to approximately 0.1 as the Sr-content is increased further. The author thanks A.G. Nazarenko, A.L. Kasatkin, A.E. Pashitskiy, and A.V. Semenov for assisting with numerical calculations and with analysis of literature on this subject, V.M. Loktev, V.M. Pan, V.B. Timofeyev, and G.M. Eliashberg for helpful discussions, and Ye.G. Maksimov for constructive critique. Figures 13; references 110.

Interaction of Microwaves in Granular Y-Ba-Cu-O Superconductor

937K0230B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 3, Mar 93 (manuscript received 25 May 92) pp 942-950

[Article by A.Ye. Koshelev, G.I. Leviyev, and R.S. Papikyan, Institute of Solid-State Physics at Russian Academy of Sciences]

[Abstract] An experimental study of granular Y-Ba-Cu-O high-temperature superconductor ceramic was made concerning its response to microwave radiation. A tablet 2 mm thick and 18 mm in diameter was placed on the bottom of a cylindrical cavity resonator, the latter having been tuned to two frequencies simultaneously: 9.4 GHz and 18.4 GHz. The stronger 9.4 GHz pumping radiation was modulated with square-wave microsecond pulses, its power being varied over the 0-51 W wide range by means of an attenuator and measured with a thermistor bridge prior to incidence on the ceramic. The weaker continuous-wave 18.4 GHz probing radiation was passed through a second attenuator and from here through arms 1,2 of a double bridge followed by a third attenuator prior to incidence on the ceramic. Each attenuator was electrically driven. The double bridge was inserted for measuring the surface impedance of the ceramic at the 18.4 GHz frequency: its arm 3 (opposite arm 2) being connected through a fourth attenuator to a movable waveguide plunger, its arm 4 (opposite arm 1) being connected through one diode to a stroboscopic integrator and through another diode to a d.c. voltmeter. The voltage across each diode represented the result of interference of two centimetric waves reflected by the resonator and by the plunger respectively. The reflection coefficient of the resonator varied throughout the duration of a power-modulating pulse. Measurements were made at a 79 K temperature without and with a constant external magnetic field, its intensity being varied over the 0-180 Oe wide range. The main object of measurements was the electrical surface resistance of the Y-Ba-Cu-O ceramic specimen at the 18.4 GHz frequency of probing radiation: the dependence of its relative change on the intensity of the constant magnetic field and on the power of incident 9.4 GHz pumping radiation (alternating magnetic field). The amplitude of pumping waves at the surface of the ceramic was in this experiment $H_{max} \approx \alpha P^{1/2}$ (P- power of pumping microwave radiation, $\alpha \approx 1.2$ Oe/$W^{1/2}$)nonlinear microwave response characteristic of Y-Ba-Cu-O ceramic to incident microwave radiation. This nonlinearity is interpreted on the basis of a theoretical model of a granular superconductor whose physical properties depend largely on the ratio of granule dimension to Josephson field penetration depth and of a Josephson junction in such a material whose response to an alternating magnetic field obeys the sine-Gordon equation. Calculations based on this equation yield for the impedance (resistance) of such a Josephson junction under conditions of the experiment a relative decrement $(R_{J,max} - R_{J,sat})/R_{J,max}$ of about 0.04, while calculations based on measurements yield approximately 0.01 for this relative decrement. The evidently stronger influence of an alternating magnetic field than that of a comparable constant one on the surface impedance of a ceramic superconductor may be attributable to different distributions of alternating and constant currents in it. The authors thank V.F. Gantmakher, A.A. Golubov, D.W. Cooke, H. Mueller, A.M. Portis, and M. Hayn for helpful discussions. Figures 6; references 16.

System of Equations for Transient-State Superconductor Dynamics

937K0230C Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 103 No 3, Mar 93 (manuscript received 23 Jul 92) pp 981-985

[Article by A.N. Orayevskiy, Institute of Physics imeni P.N. Lebedev at Russian Academy of Sciences]

[Abstract] A system of two equations is proposed for description of the nonlinear superconductor dynamics in space and time: the Ginzburg-Landau equation of kinetics for free quasi-particles in the quasi-stationary approximation and an equation of kinetics for the complex order parameter based on the law of conservation for the number of particles. Both equations and Maxwell's equations, to which they are coupled through the supercurrent density, will describe the dynamics of the electromagnetic field. Inasmuch as both recombination and collision integrals depend on the phonon concentration, the equation of kinetics for phonons will describe the dynamics of excess phonons. Insertion of the equilibrium distribution function of quasi-particles into the equation of kinetics for the complex order parameter will reduce the recombination integral to zero. The total quasi-particle concentration will then depend only on the temperature and this equation will become the classical Ginzburg-Landau equation for the order parameter. References 15.

END OF FICHE DATE FILMED

16 SEPT 1993